CLASS 9 SCIENCE

CHAPTER 7 • WORK, ENERGY, AND SIMPLE MACHINES

NUMERICAL PROBLEMS • Practice + Answers

Formula Sheet: $W = F \times s$ | Work–Energy theorem: $W = \Delta K$ | $K = ½mv^2$ | $U = mgh$ | Mechanical energy = $K + U$ | $P = W/t$ | MA = Load/Effort | Ideal lever: F■d■ = F■d■

1. A constant force of 50 N moves an object through 8 m in the direction of the force. Calculate the work done.

Answer: $W = F \times s = 50 \times 8 =$ **400 J**.

2. A force of 120 N acts opposite to the displacement of 0.25 m while stopping an object. Calculate the work done by the force.

Answer: Taking displacement opposite to force: $W = 120 \times (–0.25) =$ –**30 J**.

3. A 5 kg bag is lifted vertically through 3 m. Take g = 10 m/s². Calculate the work done against gravity.

Answer: $W = mgh = 5 \times 10 \times 3 =$ **150 J**.

4. A 10 kg object is lifted through 5 m. Take g = 9.8 m/s². Find its gravitational potential energy.

Answer: $U = mgh = 10 \times 9.8 \times 5 =$ **490 J**.

5. A 2 kg object moves with a speed of 6 m/s. Calculate its kinetic energy.

Answer: $K = ½mv^2 = ½ \times 2 \times 6^2 =$ **36 J**.

6. A 4 kg ball has kinetic energy 200 J. Find its speed.

Answer: $K = \frac{1}{2}mv^2$. Therefore $v = \sqrt{(2K/m)} = \sqrt{(400/4)} =$ **10 m/s**.

7. A 5 kg object is moving at 4 m/s. Calculate its kinetic energy.

Answer: $K = \frac{1}{2} \times 5 \times 4^2 =$ **40 J**.

8. A 1000 kg car increases its speed from 10 m/s to 20 m/s. Calculate the change in kinetic energy.

Answer: $\Delta K = \frac{1}{2}m(v^2 - u^2) = \frac{1}{2} \times 1000 \times (400 - 100) =$ **150,000 J**.

9. A 3 kg object is moving at 10 m/s and is brought to rest. Calculate the work done by the stopping force.

Answer: Change in kinetic energy $= 0 - \frac{1}{2} \times 3 \times 10^2 = -$**150 J**.

10. A 2 kg object starts from rest and gains 100 J of kinetic energy. Find its final speed.

Answer: $100 = \frac{1}{2} \times 2 \times v^2$, so $v^2 = 100$ and $v =$ **10 m/s**.

11. A 20 kg object is raised to a height of 4 m. Take $g = 10\ m/s^2$. Find its potential energy.

Answer: $U = mgh = 20 \times 10 \times 4 =$ **800 J**.

12. An object of mass 10 kg has 500 J of gravitational potential energy at a height h. Take $g = 10\ m/s^2$. Find h.

Answer: $mgh = 500$, so $h = 500/(10 \times 10) =$ **5 m**.

13. A 2 kg ball is dropped from a height of 20 m. Ignore air resistance and take $g = 10\ m/s^2$. Find its initial potential energy.

Answer: $U = mgh = 2 \times 10 \times 20 =$ **400 J**.

14. For the same 2 kg ball, calculate its kinetic energy just before reaching the ground if mechanical energy is conserved.

Answer: Initial mechanical energy = 400 J. Just before ground, $U \approx 0$, so K = **400 J**.

15. A 2 kg ball falls from 20 m. Taking $g = 10\ m/s^2$ and ignoring air resistance, find its speed just before reaching the ground.

Answer: $\frac{1}{2}mv^2 = mgh$, so $v = \sqrt{(2gh)} = \sqrt{(400)} =$ **20 m/s**.

16. A 5 kg object has kinetic energy 250 J. Find its speed.

Answer: $v = \sqrt{(2K/m)} = \sqrt{(500/5)}$ = **10 m/s**.

17. A machine does 6000 J of work in 20 s. Calculate its average power.

Answer: $P = W/t = 6000/20$ = **300 W**.

18. A weightlifter lifts a 75 kg mass through 2 m in 5 s. Take $g = 10\ m/s^2$. Calculate the power required.

Answer: $W = mgh = 75\times10\times2 = 1500$ J. $P = 1500/5$ = **300 W**.

19. A machine performs 12,000 J of work in 30 s. Find its power in watts and kilowatts.

Answer: $P = 12000/30$ = **400 W = 0.4 kW**.

20. A car engine does 50,000 J of useful work in 10 s. Calculate its power.

Answer: $P = W/t = 50000/10$ = **5000 W = 5 kW**.

21. A machine lifts a load of 600 N using an effort of 150 N. Calculate its mechanical advantage.

Answer: MA = Load/Effort = 600/150 = **4**.

22. A simple machine has mechanical advantage 5 and an effort of 80 N. Find the load it can lift.

Answer: Load = MA × Effort = 5×80 = **400 N**.

23. A pulley system lifts a 900 N load with an effort of 300 N. Find its mechanical advantage.

Answer: MA = 900/300 = **3**.

24. A lever has an effort of 50 N and lifts a 200 N load. Find its mechanical advantage.

Answer: MA = Load/Effort = 200/50 = **4**.

25. A lever has effort 40 N acting through 0.5 m. The load is 100 N. Assuming an ideal lever, find the load-arm length.

Answer: Using F■d■ = F■d■: 40×0.5 = 100×d■, so d■ = **0.20 m**.

ANSWER CHECKLIST

Chapter 7 • Work, Energy, and Simple Machines

Problem	Final Answer	Problem	Final Answer
1	**W = F × s = 50 × 8 = 400 J.**	13	**U = mgh = 2×10×20 = 400 J.**
2	**Taking displacement opposite to force: W = 120 × (−0.25) = −30 J.**	14	**Initial mechanical energy = 400 J. Just before ground, U**
3	**W = mgh = 5 × 10 × 3 = 150 J.**	15	**½mv^2 = mgh, so v = √(2gh) = √(400) = 20 m/s.**
4	**U = mgh = 10 × 9.8 × 5 = 490 J.**	16	**v = √(2K/m) = √(500/5) = 10 m/s.**
5	**K = ½mv^2 = ½ × 2 × 6^2 = 36 J.**	17	**P = W/t = 6000/20 = 300 W.**
6	**K = ½mv^2. Therefore v = √(2K/m) = √(400/4) = 10 m/s.**	18	**W = mgh = 75×10×2 = 1500 J. P = 1500/5 = 300 W.**
7	**K = ½ × 5 × 4^2 = 40 J.**	19	**P = 12000/30 = 400 W = 0.4 kW.**
8	**ΔK = ½m(v^2−u^2) = ½×1000×(400−100) = 150,000 J.**	20	**P = W/t = 50000/10 = 5000 W = 5 kW.**
9	**Change in kinetic energy = 0 − ½×3×10^2 = −150 J.**	21	**MA = Load/Effort = 600/150 = 4.**
10	**100 = ½×2×v^2, so v^2 = 100 and v = 10 m/s.**	22	**Load = MA × Effort = 5×80 = 400 N.**
11	**U = mgh = 20×10×4 = 800 J.**	23	**MA = 900/300 = 3.**
12	**mgh = 500, so h = 500/(10×10) = 5 m.**	24	**MA = Load/Effort = 200/50 = 4.**
25	**Using F■d■ = F■d■: 40×0.5 = 100×d■, so d■ = 0.20 m.**		

Source alignment: Chapter 7 covers work done by a constant force, the work–energy theorem, kinetic and potential energy, conservation of mechanical energy, power, and simple machines including pulley, inclined plane and lever/mechanical advantage. ■filecite■turn218file1■L122-L162■ The chapter gives worked numerical examples including negative work of –30 J, the 15000 kg jet stopping example (70 m/s), potential energy U = mgh, power examples, and lever work relation F■d■ = F■d■. ■filecite■turn219file4■L345-L354■ ■filecite■turn219file1■L102-L126■ ■filecite■turn219file5■L419-L433■ ■filecite■turn219file6■L477-L514■ ■filecite■turn219file2■L180-L204■